BUILDING INFORMATION MODELLING (BIM) SOFTWARE FOR FACILITIES MANAGEMENT (FM)

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ABSTRACT

Building Information Model (BIM) use and associated intelligent data in the construction industry has previously been investigated underlining an issue in its use for the Facilities Management (FM) stage. In this paper, the highlighted knowledge gap is investigate from the perspective of industry professionals who are using BIM models to support current Computer-aided facility management (CAFM) processes, using an on-line questionnaire. Findings from a pre-notified online (LimeSurvey™) questionnaire showed that Northern Ireland (NI) industry considers BIM is progressing at a similar rate or slightly less than the rest of the UK. Findings indicate weaknesses in BIM models being used for FM processes due to interoperability issues (the majority are transferred in 2D format) and lack of skilled labour. Findings indicate in NI, only 33% use of Industry Foundation Classes (IFC) compared to a UK wide figure of 63% (NBS, 2016). COBIE data drops were only utilized on 19% of projects compared to the NBS (2017) UK wide figure of 42%. Only 24% of clients were capable of using BIM for FM, climbing to 36% willing to implement FM data into an Asset Information Model (AIM) to evaluate their systems of working. These low figures suggest that much more can be delivered through government departments deciding on a route to deliver these savings through being more prescriptive. Savings at the earlier stages of the process were only realized when the NI public sector mandated BIM during design and construction in 2016. This client desire created implementation and capacity. It needs a similar mandate to achieve savings at the UK FM stage. Bulgaria has not yet mandated BIM for construction at either stage. The findings of this study can assist in showing that without a mandate uptake is low. However, Bulgaria can achieve savings at all project stages, through mandating BIM.

Keywords: *Building information modeling, Facilities management*

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1. BACKGROUND TO BUILDING INFORMATION MODELLING (BIM)

Building Information Modelling (BIM) has been mandated at the design and tender stages of the construction industry since 2016 [1]. However, Eadie et al (2013) [2] showed that it is not being implemented at all stages in a similar amount. They showed that although Facilities Management (FM) is determined as the stage where the second biggest cost savings can be achieved it is also the stage with the lowest uptake of BIM. Due to the knowledge gap in this regard as to why this might be, this paper examines the Facilities Management phase to rank the barriers holding BIM back from being fully implemented.

PAS1192-2 (BSI,2013) [3] sets the British Standard for the contents of the Employer's Information Requirements (EIR) and stipulates that uses should be stated at an early stage of contract discussions and follow the development of stages planned out in the BIM Execution Plan (BEP). The agreed model purpose should be outlined in the agreed Plan of Works (POW) method that the selected contract uses. However, what has previously not been examined is a comparison with Northern Ireland use and the remainder of the UK.

Ashworth et al., (2016) [4] suggests that FM companies use diagnosis with plain language questions (PLQ) to analyze the Organizational Information Requirements (OIR) and Asset Information Requirements (AIR) for each new job. This should be carried out prior to the contract being awarded and the information gathered incorporated into the specific model stage. The highlighted concern was that FM organizations rely heavily on internal Computer-Aided Facility Management (CAFM) systems and therefore lack visibility of the wide range of BIM documentation and standards open to others at the design stage.

Shepherd, (2015) [5] highlighted a number of difficulties relating to the interoperability of sharing information from preliminary BIM models to CAFM software alongside other FM objectives such as financial savings, Construction Operations Building Information Exchange (COBie) uses and security of data. However, these were not ranked in order of importance. This paper seeks to examine this knowledge gap.

1.1. Literature Review of Factors holding back BIM at FM Stage

Motamedi et al. (2014) [6] show that the FM phase has potential for savings, providing an example with a 30-year life cycle, and showing that the operational and maintenance (O&M) costs are five times greater than the asset net worth over that same period. Zeiss, (2013) [7] fully supports this showing the Operational Expenditure (OpEx) plus Capital Expenditure (CapEx) sums up to Total Expenditure (TotEx) of a project suggesting therefore that "*the largest prize for BIM lies in the operational stages of the project life-cycle*". However, in order for these to be realized barriers need to be overcome as the uptake according to Eadie et al (2013) [2] is still low. There was also a knowledge gap in relation to determining the use of BIM for FM in Northern Ireland compared to the rest of the UK.

An examination of the literature indicated the following barriers to BIM implementation in FM. NBS (2017) [8] show that although 70% of projects in the survey have now achieved the Government requirement of level 2 status, only 50 % of respondents described themselves as undecided or not very confident in BIM knowledge and skills. However, it is not known if this is a major barrier to BIM implementation at FM stage. O'Hagan, (2016) [9] suggested that suppliers have a responsibility to deliver the correct data at the initial stages of model development and expressed concern with companies experience levels in estimating the correct value for the additional time required for reworking parts of a BIM model for FM citing an example of window design for Her Majesty's Prison (HMP) Maghaberry prison.

The Department for Business Innovation & Skills, (2013) [10] states that UK supply chains Data Management is completed by larger US corporations and suggested difficulties for smaller entrants into the market to allow decentralization and innovation. Of further note, they suggested 75% of the supply chain are lacking in IT infrastructure.

Eadie et al (2015) [11] highlighted the legal issues related to BIM generally. The top four highest ranked BIM legal issues were: 1 Model ownership, 2 Incorporation of BIM into the contractual relationship of the parties involved, 3 Design liability and 4 Reliance on data. These also apply at FM stage.

The BIM models themselves come under scrutiny in Malleson et al., (2012) [12] who emphasizes the "Level of Detail" (LOD) required for COBie drops and the merging of different models to allow FM firms to manage one spreadsheet with standard naming conventions. This shows the importance of getting the initial stages correct in the formation of the BIM model and the importance of transferring the data in a useable format. Issues such as interoperability between disciplines in software and the need to take a whole project cycle approach to transition into COBie are vital to the success of using the intelligent data in the BIM model to manage latter stage activities. Industry Foundation Classes (IFC) have been suggested as a means of transferring BIM models to FM software. However, Yalcinkaya and Singh, (2015) [13] suggest that the generic nature of the IFC standards and their complexity, is an issue for directly linking BIM models to FM software. The use of COBie and (IDC) at FM stage for interoperability has been little investigated and will be examined in this paper.

The separation of FM from the designers has been highlighted as a major issue in sustainability in Bröchner et al (2019) [14], and it has been suggested that the digital element may be a way to resolve this. However, a BIM model still does not allow communication with the designers after construction is complete and handover has taken place. Farrell and Metha (2015) [15] suggest that an Information manager should have input at all stages of the project to overcome this. This would allow this person to also update the model information for FM. However, on smaller jobs without an information manager this will still be an issue. The role of senior management in supporting BIM in FM through ensuring the correct personnel fulfil the role of the information manager and providing training is imperative in its successful use according to Becerik-Gerber et al (2012) [16].

PAS1192-5, (CPNI, 2015), [17] lists the security concerns of sharing of unedited asset information to improve long term asset management including cloud based software security and access issues. The key to limit the unintentional theft of information is to have the security imbedded into both the design and FM organizational structure. However, full transparency suggested by some codes and guidance documents conflicts with this. The impact of this conflict has not been previously investigated.

1.2. Literature Review on opinions of sharing BIM models at FM Stage

Eadie et al (2013) [2] indicated that 71% often transfer the BIM models to the FM stage in 2D format. Until this paper the perceptions of those from a FM standpoint have not been examined. A list of uses for BIM models was built up from literature from the design stage. This was examined in depth via an on-line survey.

2. RESEARCH METHOD

Those organizations responsible for FM work in Northern Ireland (NI) were selected. The total population consisted of 115 firms who were Royal Society of Ulster Architects (RSUA) members, 25 Association for Consultancy Engineering (ACE) members and the 8 member FM companies in the NI Directory of the British Institute of Facility Managers (BIFM). The RSUA sample was refined to remove all organizations in the 6 "Small Domestic" categories as they are not related to FM. This reduced the eligible number of FM related RSUA members to 64. ACENI members were contacted and only 12 responded that they were responsible for overseeing FM work. Those that responded to say they carried out work for other FM organisations were excluded. This gave a total population of 84. The number of responses received was 42, giving a 50% response rate. Using a confidence level of 90%, 10% margin of error, the formula $n = [z^2 * p * (1 - p) / e^2] / [1 + (z^2 * p * (1 - p) / (e^2 * N))]$ where $z = 1.645$ for a confidence level (α) of 90%, p = proportion (expressed as a decimal assumed at worse case of 50%), N = population size 84, e = margin of error 10%. In our case, this provided 38 as the minimum sample size which is less than the 42 actual responses, thus showing that the survey is statistically valid. Pre notification was carried out with 53 RSUA members, 9 ACE members and 1 BIFM member agreeing to carry out the survey. The breakdown of membership and responses is given in Table 1.

After Pre notification those who agreed to complete the survey were sent a structured questionnaire through the Limesurvey™ software with responses gathered in a MYSQL database for analysis. Questions provided a bipolar scale -2 to +2 for response with the following typical scale: "-2 Disagree Strongly; -1 Disagree; 0 Neither Disagree or Agree / Undecided; +1 Agree; +2 Agree Strongly". Therefore disagree ranking findings are denoted by a negative and agree by a positive number. These ranking questions were followed by qualitative questions to gauge why the opinions were provided.

Table 1 Respondent breakdown

Organisation	**No. Members**	**No. Acceptance Pre notification**	**No. Completed Response**
RSUA	64	53	33
ACE	12	9	8
BIFM	8	1	1
Total	84	63	42

3. FINDINGS

3.1 BIM Delivery in Northern Ireland compared to the rest of the UK

The findings presented in Table 2 indicate that the majority of organizations consider that NI is progressing similar to England, Scotland and Wales in implementing BIM for FM (46.34%). However, there is a much wider split between those who think it is not as well used (41.46%) and those who think NI has gone beyond the rest of the UK (12.20%). This indicates that NI is in a similar position or just slightly behind England , Scotland and Wales in implementing BIM for FM.

Table 2 BIM Delivery in Northern Ireland compared to the rest of the UK

BIM FM delivery in Northern Ireland is progressing well in relation to the rest of the UK			
Answer	Count	Percentage	Sum
1 - Disagree Strongly	4	9.76%	41.46%
2 - Disagree	13	31.71%	
3 - Similar / Undecided	19	46.34%	46.34%
4 - Agree	5	12.20%	
5 - Agree Strongly	0	0.00%	12.20%
Sum (Answers)	41	100.00%	100.00%

3.2 Main Concerns in using BM for FM in their company

The findings presented in Table 3 investigate the main concerns organizations have in using BIM for FM. Organizations were asked to select all the concerns that applied to them. The highest number of organizations (12) jointly ranked "Availability of skilled professionals to ask advice" and "Accuracy of information, tolerance, revisions and possible data errors" as the topmost concerns. This shows that the communication break between the design and FM stages is a major issue in relation to BIM. The role of the information manager to be the go between therefore becomes critical to the success. The need for "As-built" BIM drawings to be updated for FM purposes is also necessary. The third ranked element relates to Data Management and the time taken to do these updates for FM. This shows that clarity must be given legally to the roles and responsibilities in the EIR document. The issues related to interoperability and skills and staff in the literature review also rank highly in Table 3. Cloud based software does not seem to be an issue as only one organization highlighted this.

Table 3 Main Concerns in using BM for FM in their company

Main concerns in using or implementing BIM for FM in the company	No	%	Rank
Availability of skilled professionals to ask advice	12	10.00	1
Accuracy of information, tolerance, revisions and possible data errors	12	10.00	1
Data management - Time taken to input information or increasing data handing	11	9.17	3
Legal issues including EIR & Contracts	10	8.33	4
Financial Issues	10	8.33	4
Integrating BIM successfully with the organisations internal CAFM softwares	9	7.50	6
Commitment of Senior Management	9	7.50	6
Training and available support of unknown practices	8	6.67	8
Unclear responsibility of persons at model stages or updates	8	6.67	8
Softwares' interoperability or hardware issues	8	6.67	8
Other (Please state)	7	5.83	11
Clarity or mixed messages in standards	6	5.00	12
None	5	4.17	13
Security of Information	3	2.50	14
Cloud based software security / access issues	1	0.83	15
PM software that integrates seamlessly with model stages	1	0.83	15
Total		100%	

3.3 Uses of BIM modelling during FM

The bipolar scale highlighted the lack of constant use of BIM for FM at the moment. Table 4 shows all of the factors below are negative. This means that there is not as much use as there could be for BIM in FM. Table 4 also indicates that for FM the biggest use of BIM models for was creating the handover documentation in 2D format. It can be seen that the creation of models in 2D format in PDF is much higher ranked (1) than those in IFC / COBie (11). This is further developed in Section 3.4.

Table 4 Uses of BIM modelling during FM

Function	Factored Weighting	Rank
Handover the model in 2D format as PDF or otherwise	-45.000	1
To produce 2D drawings	-46.154	2
To produce 3D models	-50.000	3
Obtaining clash controls / space planning	-76.923	4
To provide a collaborative working means	-91.892	5
For the ability to share models outside of your organization	-92.308	6
Provide a visual walkthrough for clients	-105.128	7
Provide a model environment that took advantage of several types of software	-133.333	8
The use of data rich information behind the model	-134.211	9
Provide a whole-life model design	-157.895	10
Handover the model to allow FM of assets using IFC or COBIE	-161.111	11
Scheduling of resources or work order management	-171.795	12
Energy management	-172.222	13
QS costing features	-173.684	14

3.4 Use of COBie and IFC in BIM models for FM

The results of the two questions in this section indicate that IFC's are used more than COBie data within FM. Results indicated that 34.15% of respondents had used IFC's on projects they had been working on in the previous year. However, only 19.51% had used COBie. This indicates that there is the possibility of interoperability being improved so that intelligent data can be shared and the results from the next section indicates that it is considered a good idea.

3.5 Opinions on sharing of BIM models for FM

In Table 5 all the Factored Weightings are all positive. This indicates that people are positive about the drivers for BIM for FM. This shows that although it is scarcely used from the results of the previous section that the positives are acknowledged. It suggests that there would be support for BIM for FM from the users should the government bring in a similar requirement to design stage.

Table 5 Opinions on sharing of BIM models for FM

Opinions on handover of BIM models	Factored Weighting	Rank
It is a good idea to handover 3D models for use in management of assets	110.714	1
It is an invaluable tool for facility managers	100	2
I am the model author I should have rights to model uses or be reimbursed for visibility	86.364	3
Inaccurate building models may require rework to get up to standard	79.310	4
Risk to security of project information	69.565	5
Lack of controls on model responsibility	60	6
Duplication of information may occur	36.842	7

3.6 Opinions on Capacity, Client desire and implementation

The findings indicate that when asked if they believed that clients are capable of implementing FM data into an asset information model for evaluating their systems of work: 76.19 % said no and 23.81% considered they had the capacity. The negative percentage reduced to 64.29% when asked if clients were willing to implement FM data into an asset information model for evaluating their systems of work. This meant that only 35.71% of clients were willing. The reluctance to use BIM was further emphasized in the third question in this section where only 7% of FM organizations were considered to be reaching out sufficiently to implement their profile within the construction industry to allow the potential benefits of BIM to be realized. This shows that more work needs to be done to promote the benefits of BIM for FM, both from a client and FM organization perspective. The qualitative responses included the need for current FM systems to incorporate these methods of transfer: *The current FM systems have been too slow to react to COBie and IFC as input methods which means that clients have to find ways around this problem.* The need for some simplified versions of FM software designed to suit clients is also highlighted in the responses: *Clients aren't skilled enough to run BIM softwares. So until watered down / idiot proof / "FM software for Dummies" FM softwares are developed that are capable of being operated"* by unskilled people *"Clients"* then its use will not increase to its full potential.

4. CONCLUSIONS

The investigation into BIM for FM showed that those working in FM could see the benefits of adopting BIM. All seven benefits were ranked positively with the most important opinion that *it is a good idea to handover 3D models for use in management of assets.* However, when it came to measuring what the BIM models for FM were being used for, the figures were all negative. This showed that the current use is not as much or as good as it could be. There was recognition that the handover process was mainly in

2D PDF format. Using IFC or COBie for transmission of models was over three times less likely. This shows that while the potential for savings and efficiency is there that it has not been fully realized yet. BIM for FM in NI is at a similar stage to the rest of the UK according to 46% or just slightly less 41%. However, it has not yet started in Bulgaria. The results highlight the fact that BIM cannot fully solve the breakdown in communication between the Construction and FM stages. Once construction is complete there is no continuity in the staff at FM stage. Previous literature has suggested that this is the role of the Information Manager. However, the results in Section 3.4 indicate that this issue still needs to be examined in more depth as the current BIM models transferred in the way they are do not allow the necessary communication. Also highlighted is the need for As-built drawings to be specifically updated for FM prior to handover for the operations phase. The responsibility for this needs to be set out legally in the EIR document. While the findings indicate desire at FM operator level there is an issue with capacity and desire at client level. Only 24% considered that the clients had the capacity for BIM at FM rising to 36% for willingness. So in a similar way to the Government leading the way in stipulating the use of BIM for design in projects over the European Financial Threshold this needs to be replicated for BIM for FM Projects. A Government mandate needs to be produced to force through uptake of BIM for FM to realize the significant benefits. In Bulgaria, similar to the UK, BIM needs to be mandated at both the design and FM stages for the benefits to be achieved. If Bulgaria followed the UK lead and adopted BIM at the design stage similar documented benefits could accrue. In adopting it for all phases it could take the lead and accrue the benefits that the findings show FM organizations acknowledge. Software organizations need to also take note of the comments in relation to FM. As many organizations just oversee the FM process and unskilled people have inputs in regards to reporting faults from both client and operator sides, scaled back or simplified versions of the software packages for these inputs are vital. Software organizations need to work on their interface and have different levels of operators seeing difficulty of use specifically tailored for them. Further research will be needed to be carried out once the levels of use of BIM for FM increase.

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